Volume 48(1-4):47, 2004
Acta Biologica Szegediensis
http://www.sci.u-szeged.hu/ABS

DISSERTATION SUMMARY

Towards an efficient and integrated biogas technology

Zoltán Bagi

Department of Biotechnology, University of Szeged, Szeged, Hungary, and Institute of Biophysics, Biological Research Center, Hungarian Academy of Sciences, Szeged, Hungary

Among the significant recent advances in understanding the ecology of anaerobic biodegradation of organic wastes is the recognition of the close syntropic relationship among the three distinct microbe populations and the importance of H2 in process control. (Dolfing et al. 1992; Shi-yi et al. 1992; Shima et al. 2002) The regulatory roles of hydrogen levels and interspecies hydrogen transfer optimize the concerted action of the entire population. The concentration of either acetate or hydrogen, or both together, can be reduced sufficiently to provide a favorable free-energy change for proportionate oxidation.

During anaerobic biodegradation hydrogen concentration is reduced to a much lower level than that of acetate. In addition, the hydrogen partial pressure can change rapidly, varying by an order of magnitude or more within a few minutes. This is related to its rapid turnover rate. The energy available to the acetate-using methanogens is independent of hydrogen partial pressure, whereas that of the hydrogen-producing and hydrogen-consuming species is very much a function of it.

We have shown that under these circumstances addition of hydrogen producers to the system and thereby shifting the population balance brings about advantageous effects for the entire methanogenic cascade (Kovács et al. 1987). The decomposition rate of the organic substrate increases and both the acetogenic and methanogenic activities are remarkably amplified. In laboratory experiments some 2.6-fold intensification of biogas productivity has been routinely observed and the same results were obtained in scale-up experiments.

Proper management of the bacterial population is expected to facilitate the start-up of the fermentation. In order to reduce the costs of this treatment supplemented bacteria are grown in diluted industrial wastewater.

In contrast to the commonly used factor of 0.6-0.8 that is used to estimate biogas yields, the integrated technology, using intensified microbiological biomass decomposition, should yield a two-three fold increase when using 15% solid content biomass. The integrated technology uses sugar accumulating energy plants (e.g., sweet sorghum, Jerusalem artichoke) to increase the biodegradable biomass density.

References

Kovács K, Bagyinka Cs, Verebély I (1989) Eljárás kevert baktériumpopulációt alkalmazó fermentációs rendszer biogázt termelőképességének fokozására. Szabadalom, lajstromszám: 195 978, 1987.

Dolfing J (1992) The energetic consequences of hydrogen gradients in methanogenic ecosystems. FEMS Microb Lett 101:183-187.

Shi-yi L, Jian C (1992) The contribution of interspecies hydrogen transfer to the substrate removal in methanogenesis. Proc Biochem 27:285-289.

Shima S, Warkentin E, Thauer RK, Ermler U (2002) Structure and function of enzymes involved in the methanogenic pathway utilizing carbon dioxide and molecular hydrogen. J Bios Bioengine 93:519-530.

Supervisor: Kornél Kovács
E-mail: bagiz@nucleus.szbk.u-szeged.hu